WELCOME
TO THE DECEMBER EDITION
OF THE 2016
M&R SEMINAR SERIES

BEFORE WE BEGIN

- SAFETY PRECAUTIONS
  - PLEASE FOLLOW EXIT SIGN IN CASE OF EMERGENCY EVALUATION
  - AUTOMATED EXTERNAL DEFIBRILLATOR (AED) LOCATED OUTSIDE
- PLEASE SILENCE CELL PHONES OR SMART PHONES
- QUESTION AND ANSWER SESSION WILL FOLLOW PRESENTATION
- PLEASE FILL EVALUATION FORM
- SEMINAR SLIDES WILL BE POSTED ON MWRD WEBSITE
  (www. MWRD.org: Home Page ⇒ Reports ⇒ M&R Data and Reports ⇒ M&R Seminar Series ⇒ 2016 Seminar Series)
- STREAM VIDEO WILL BE AVAILABLE ON MWRD WEBSITE
  (www.MWRD.org: Home Page ⇒ MWRDGC RSS Feeds)

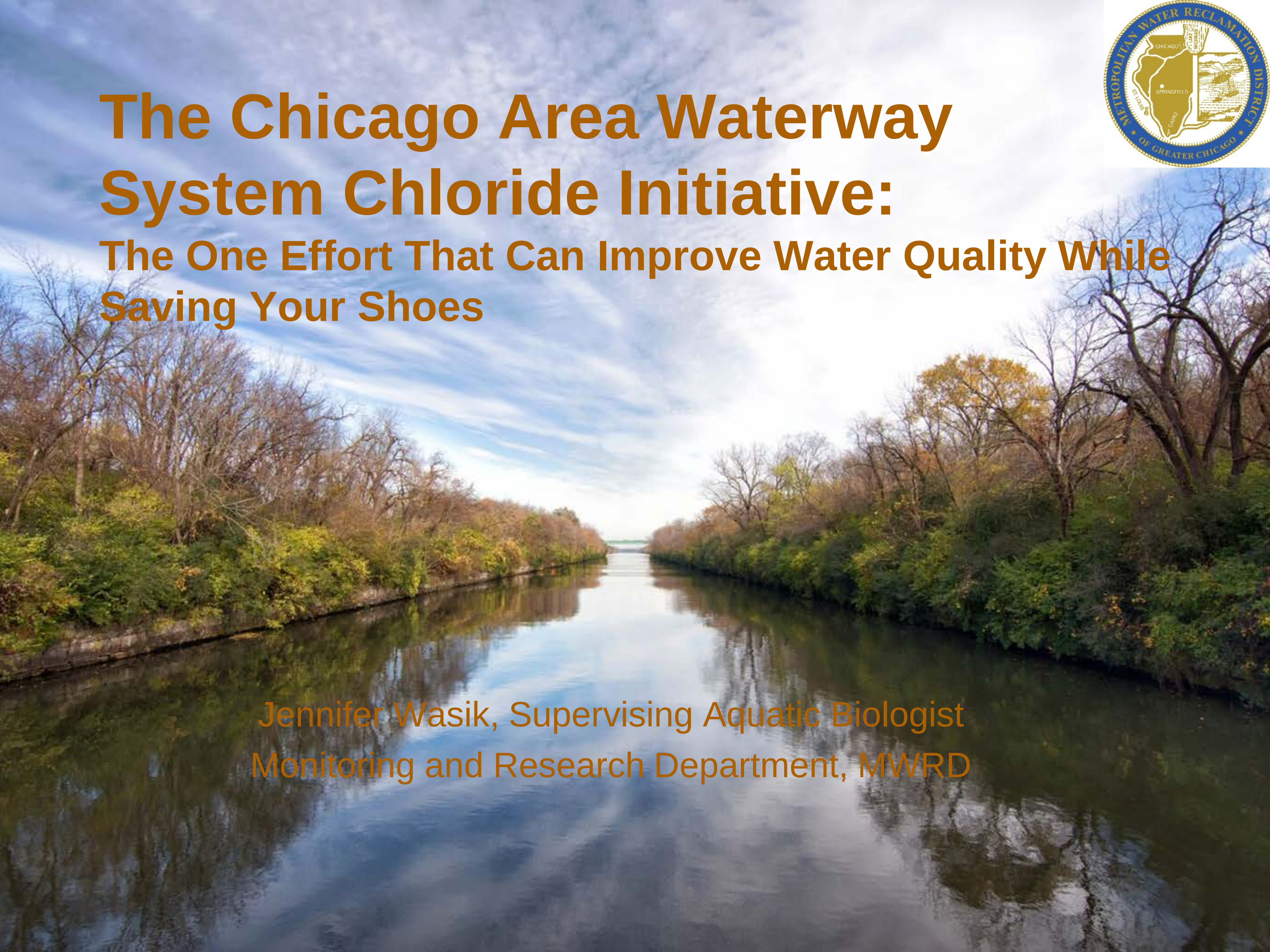
JENNIFER L. WASIK

Current: Supervising Aquatic Biologist, M&R Department,
Metropolitan Water Reclamation District of Greater Chicago (MWRD)

Experience: Manage Aquatic Ecology and Water Quality Section with 19 employees conducting ambient water quality and biological monitoring, and WET testing; Represent the District at water quality and aquatic ecology meetings, hearings, and workshops; Provide testimony and act as District witness at water quality related hearings; Interpret and analyze results of water quality assessments, write technical reports, and give presentations.
Research Assistant, *Loyola University in Chicago, IL, and Woods Hole Oceanographic Institute, Marine Biological Laboratory in Arkansas*

Education: M.Sc. in Environmental Management, Illinois Institute of Technology, Chicago, IL
B.S. in Biology, *University of Michigan,* Ann Arbor, MI

Professional: Society for Freshwater Science; International Association for Great Lakes Research;
Chair of Water Quality Committee, CAWS Chloride Initiative;
IAWA Committees on Nutrients, Water Quality, and Environmental Utility (chair)
Member of several IEPA committees, and WE&RF exploratory team



The Chicago Area Waterway System Chloride Initiative:

The One Effort That Can Improve Water Quality While Saving Your Shoes

Jennifer Wasik, Supervising Aquatic Biologist
Monitoring and Research Department, MWRD


CENSORED

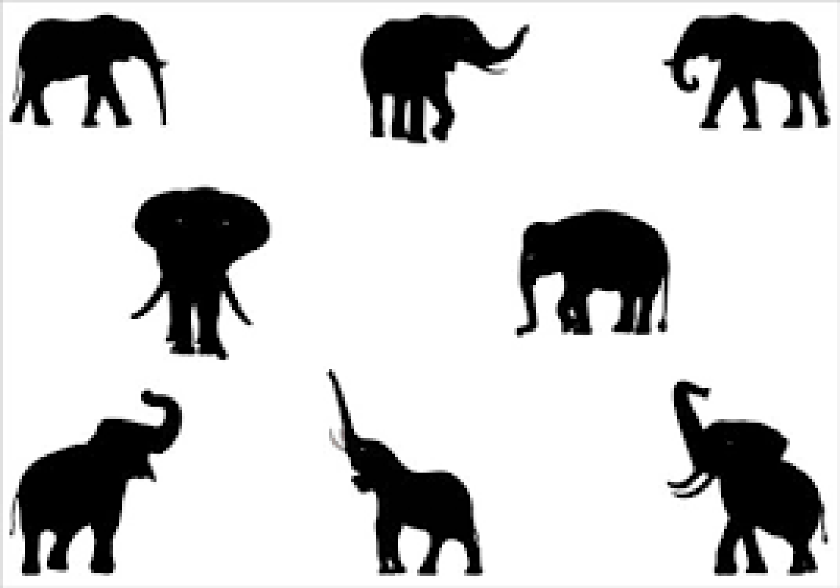
Fun Facts – Chloride Edition

- Road salt application began in 1940s in US[1]
- It takes only one teaspoon of road salt to permanently pollute 5 gallons of water.
- Annual average of 19.5 million metric tons/yr of NaCl-based road salt (2007-2011) [1]
- 471,000 metric tons of road salt were applied annually in Illinois between 2002 and 2005, mostly in Chicago region[2]
- City of Chicago Streets and Sanitation Department
  - >300 piece fleet of snow-removal trucks[3]
  - Has 374,000 tons of salt at 19 facilities across the City (only 130,000 tons used last year since it was such a mild winter) [3]

[1]Corsi, et.al. USGS, 2015
[2]Kelly, et.al, 2011
[3]https://www.dnainfo.com/chicago/20161118/west-loop/chicago-snow-2017-winter-weather-street-

Fun Facts – Chloride Edition

85,636 elephants



https://www.wisaltwise.com/

37,680 school buses

Pathways of Road Salt to Waterways

- The chloride applied to the streets makes its way into local waterways through:
  - Treated water reclamation plant effluent
  - Storm water outfalls
  - Combined sewer overflows
  - Overland runoff
  - Groundwater discharge
- Combined sewer water directed to MWRD water reclamation plants for treatment and ultimately discharged to the waterways contains chloride that is not removed by conventional treatment processes.

Social and Economic Costs of Wintery Weather

- Each year, 24 percent of weather-related vehicle crashes occur on snowy, slushy or icy pavement and 15 percent happen during snowfall or sleet.
- Over 1,300 people are killed and more than 116,800 people are injured in vehicle crashes on snowy, slushy or icy pavement annually.
- Winter road maintenance accounts for roughly 20 percent of state DOT maintenance budgets. State and local agencies spend more than 2.3 billion dollars on snow and ice control operations annually.

plowshttp://ops.fhwa.dot.gov/weather/weather_events/snow_ice.htm


M 200589

Outline

- Recent Literature on Chlorides in the Environment
- Chicago Area Waterway System (CAWS) Rulemaking and Chloride Water Quality Standards
- Local Water Quality and Effluent Data
- Purpose of the CAWS Chloride Initiative
- Activities of the Workgroup
- Other Ongoing Local Efforts on the Chloride Issue

The Chloride Issue Defined

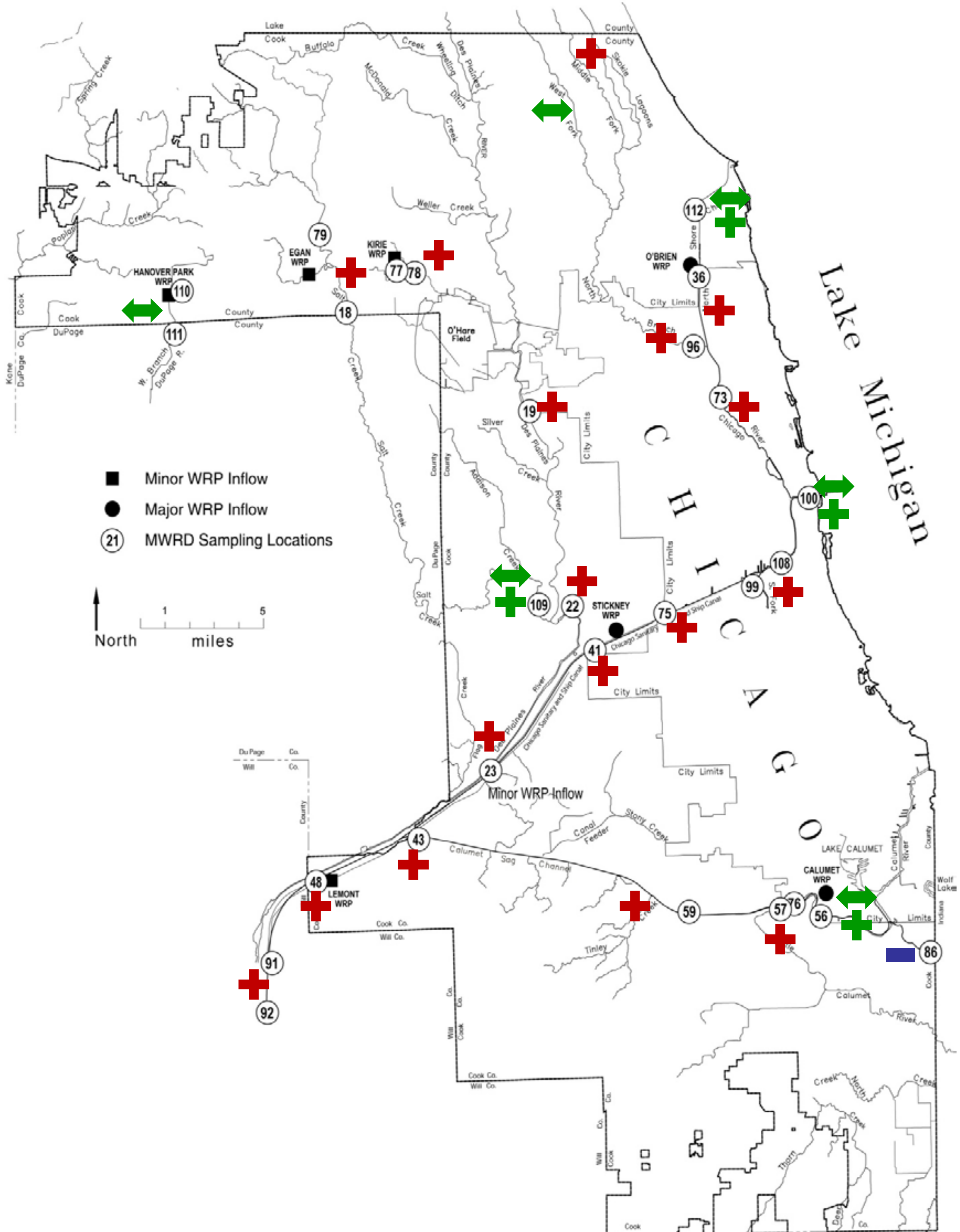
- USGS Wisconsin Water Science Center, Corsi, et.al, 2015
  - Historical data (1990-2011) were examined for 30 monitoring sites on 19 streams in northern US, including Des Plaines R., Fox R., and Poplar Creek, locally.
  - Increasing chloride trends observed in all seasons, especially winter; average concentrations doubled between 1990-2011
    - Non-winter increases indicate that chloride stored in shallow groundwater system and released in baseflow throughout the year.
  - Chronic criteria exceeded for extended durations

The Chloride Issue Defined

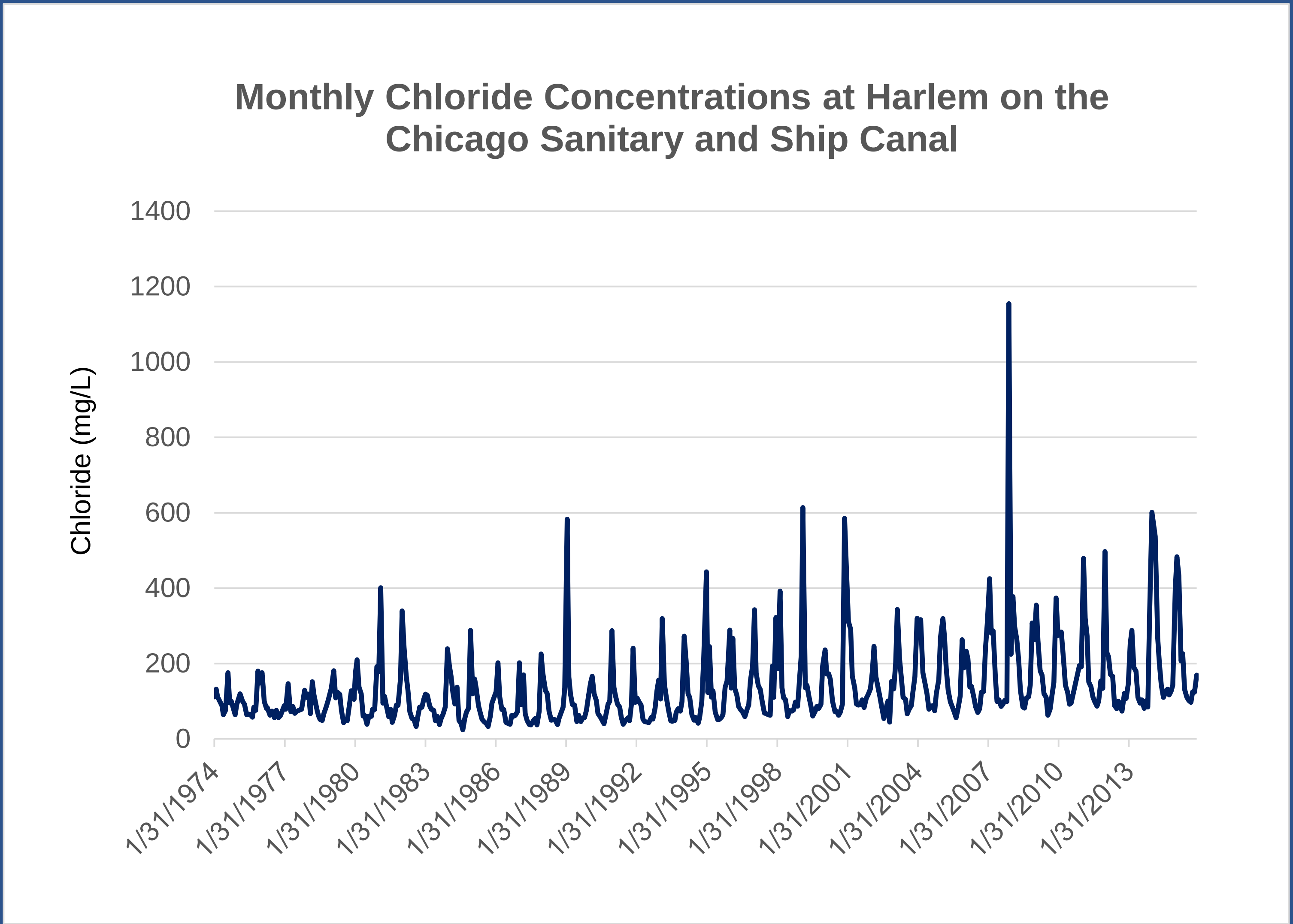
- Illinois State Water Survey, Kelly, et.al, *Impacts of Road Salt Runoff on Water Quality of the Chicago, Illinois, Region*
  - Analyzed long-term trends in chloride in surface and groundwater in Chicago region using MWRD and USGS data.
  - Significant increases in IL river and stream chloride concentrations since the 1970s.
  - Greatest chloride concentrations in smaller tributaries of the Chicago River.

Trends at Chicago Area Ambient Water Quality Monitoring (AWQM) Stations

- Mann Kendall method to look at trends in AWQM data from 1974 – 2015
- Looked at all data at each station as well as just winter and summer data individually.
- Significant increasing trend in all cases for all current AWQM stations in the Chicago Area Waterway System (CAWS) except for locations near Lake Michigan, and Grand Calumet River, which actually exhibited negative trends in all cases.
- Positive trends for many but not all smaller streams in District service area

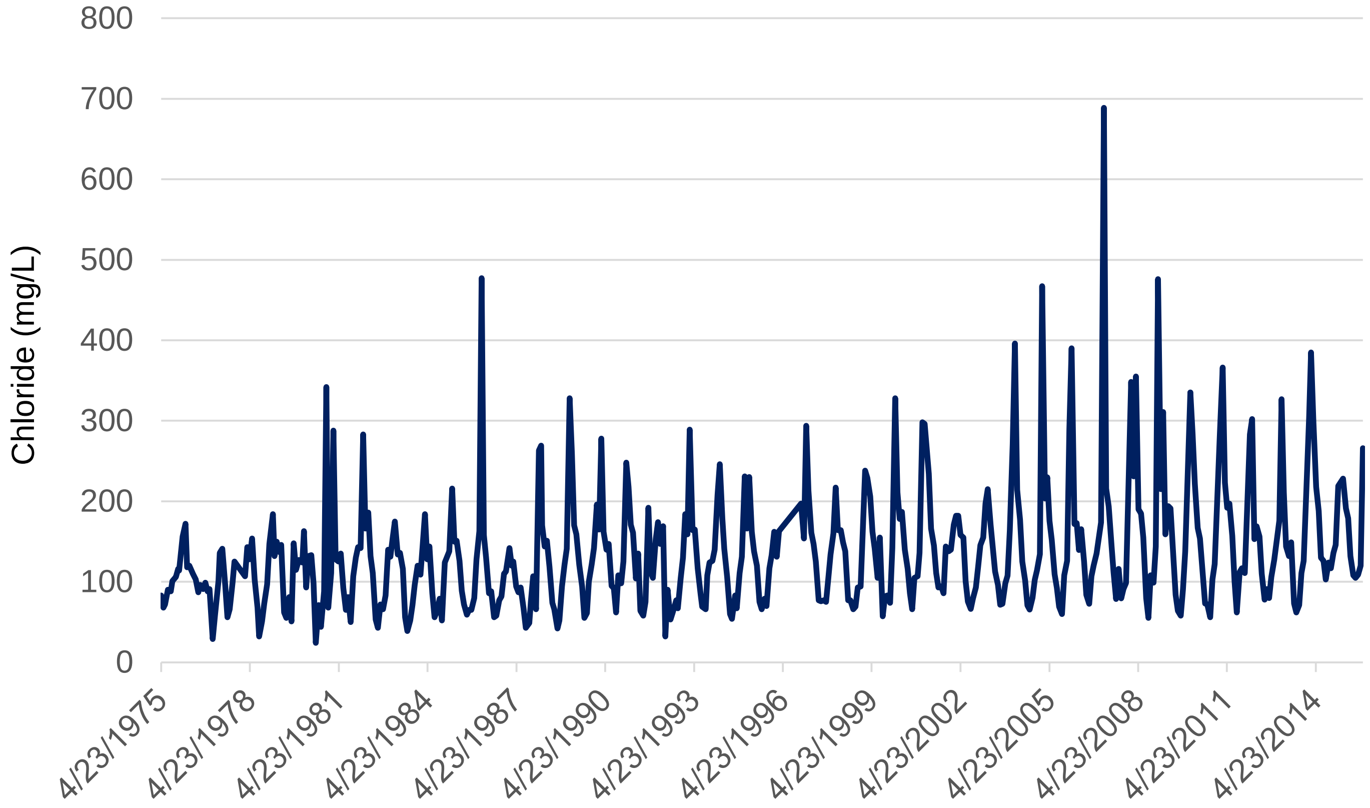


Lake Michigan
CHICAGO
Minor WRP Inflow
Major WRP Inflow
21 MWRD Sampling Locations
North
miles
HANOVER PARK WRP
EGAN WRP
KIRIE WRP
O'BRIEN WRP
STICKNEY WRP
LEMONT WRP
CALUMET WRP
LAKE CALUMET
O'Hare Field
Minor WRP Inflow
Wolf Lake



Monthly Chloride Concentrations at Harlem on the Chicago Sanitary and Ship Canal
Chloride (mg/L)
1400
1200
1000
800
600
400
200
0
1/31/1974
1/31/1977
1/31/1980
1/31/1983
1/31/1986
1/31/1989
1/31/1992
1/31/1995
1/31/1998
1/31/2001
1/31/2004
1/31/2007
1/31/2010
1/31/2013

Monthly Chloride Concentrations at Halsted Street on the Little Calumet River



Potential Impacts on Aquatic Life

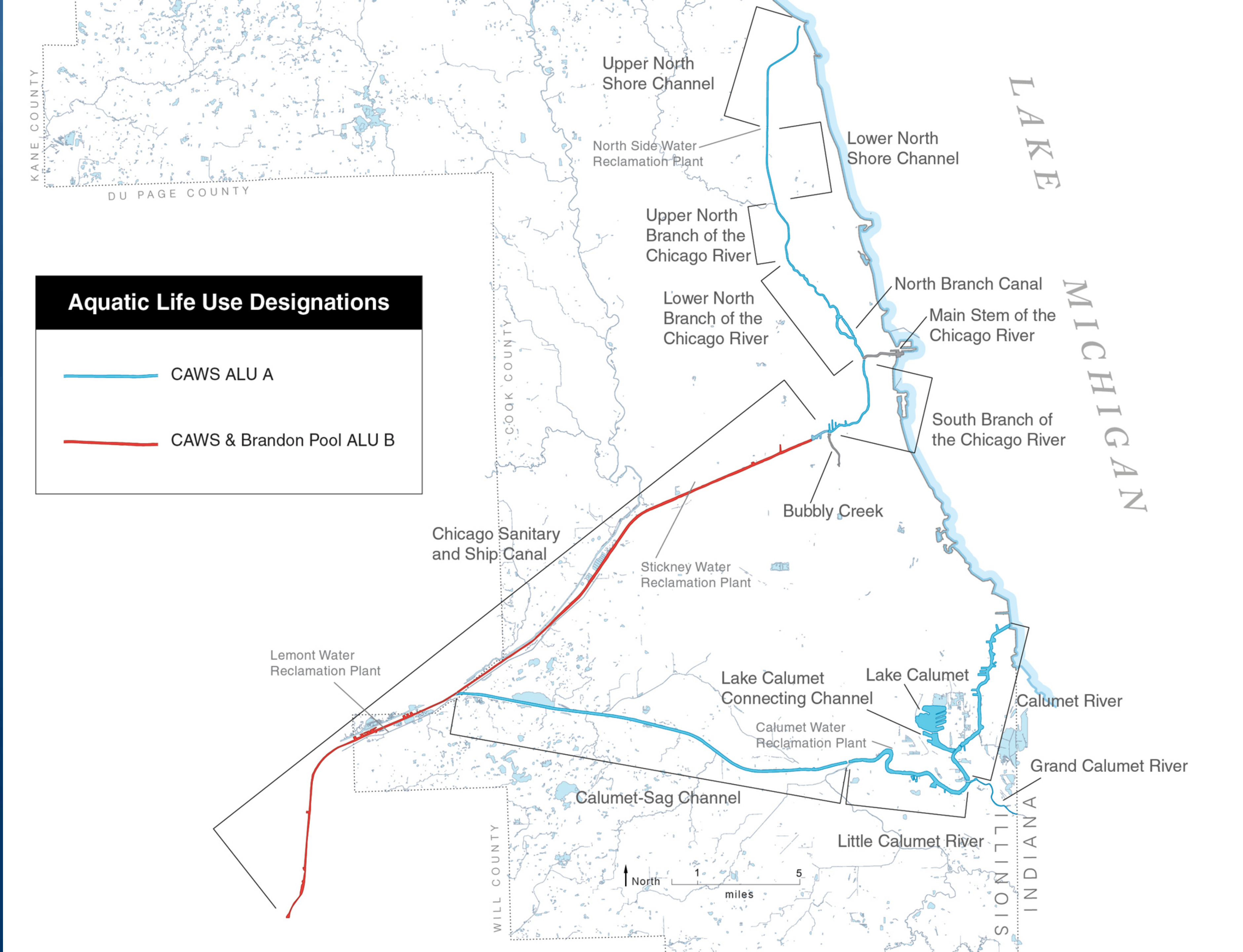
- Acute Toxicity to invertebrates and fish
- Vegetation impacts
- Growth & Reproduction
- Bacteria and algae densities
- Benthic invertebrate stream drift
- Diversity and community structure of invertebrates
- Indirect effects caused by mobilization of heavy metals

Federal Chloride Water Quality Criteria

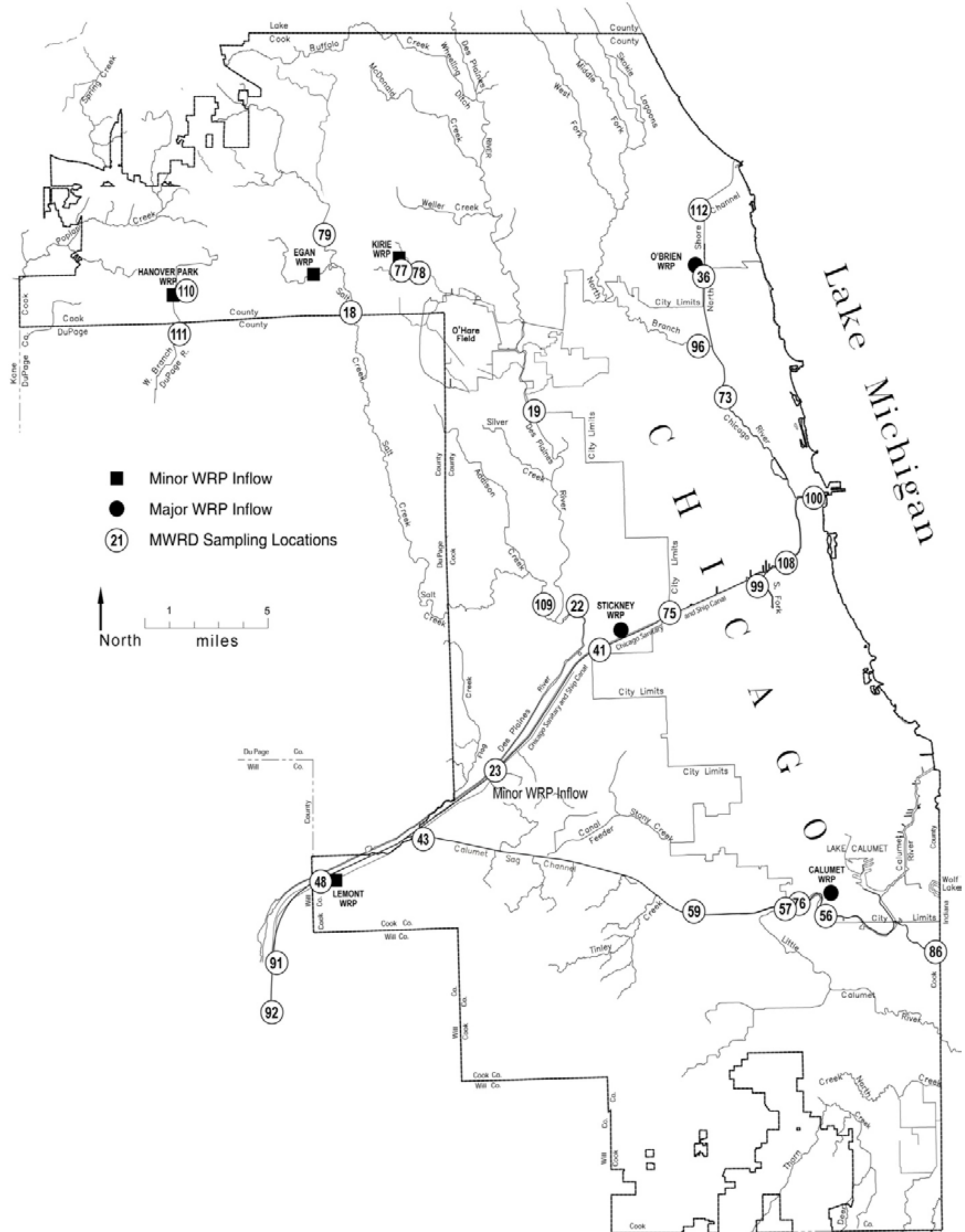
- USEPA 1986 criterion still apply
  - 860 mg/L Acute, 230 mg/L Chronic
- USEPA currently working on a revision of 1986 criteria which is expected to lower the acute standard and increase the chronic standard
- Water Quality Standards Based on *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their uses.*
  - Cumulative probabilities for the 4 most sensitive genera

CAWS Chloride Water Quality Standards

- Previously no chloride water quality standard in the CAWS; only TDS standard in Indigenous Aquatic Life Use Waters.
- Uses upgraded to CAWS A and CAWS B Aquatic Life Use Waters.
- July 1, 2015 Illinois Pollution Control Board Rulemaking set water quality standard of 500 mg/L chloride in all CAWS waterways except Chicago Sanitary and Ship Canal
  - Same as General Use Criteria in Illinois
  - Winter site specific chloride standard of 990 mg/L (anytime) and 620 mg/L (chronic 4-day average) applies in CSSC December 1 – April 30.
  - New standards effective July 1, 2018



Aquatic Life Use Designations
CAWS ALU A
CAWS & Brandon Pool ALU B
Upper North Shore Channel
North Side Water Reclamation Plant
Lower North Shore Channel
Upper North Branch of the Chicago River
Lower North Branch of the Chicago River
North Branch Canal
Main Stem of the Chicago River
South Branch of the Chicago River
Bubbly Creek
Chicago Sanitary and Ship Canal
Stickney Water Reclamation Plant
Lemont Water Reclamation Plant
Lake Calumet Connecting Channel
Lake Calumet
Calumet River
Calumet Water Reclamation Plant
Grand Calumet River
Calumet-Sag Channel
Little Calumet River
LAKE MICHIGAN
KANE COUNTY
DU PAGE COUNTY
COOK COUNTY
WILL COUNTY
ILLINOIS
INDIANA
North
1
5
miles



Lake Michigan
CHICAGO
Minor WRP Inflow
Major WRP Inflow
21 MWRD Sampling Locations
North
miles
HANOVER PARK WRP
EGAN WRP
KIRIE WRP
O'BRIEN WRP
STICKNEY WRP
LEMONT WRP
CALUMET WRP
O'Hare Field
LAKE CALUMET
Wolf Lake
Minor WRP Inflow

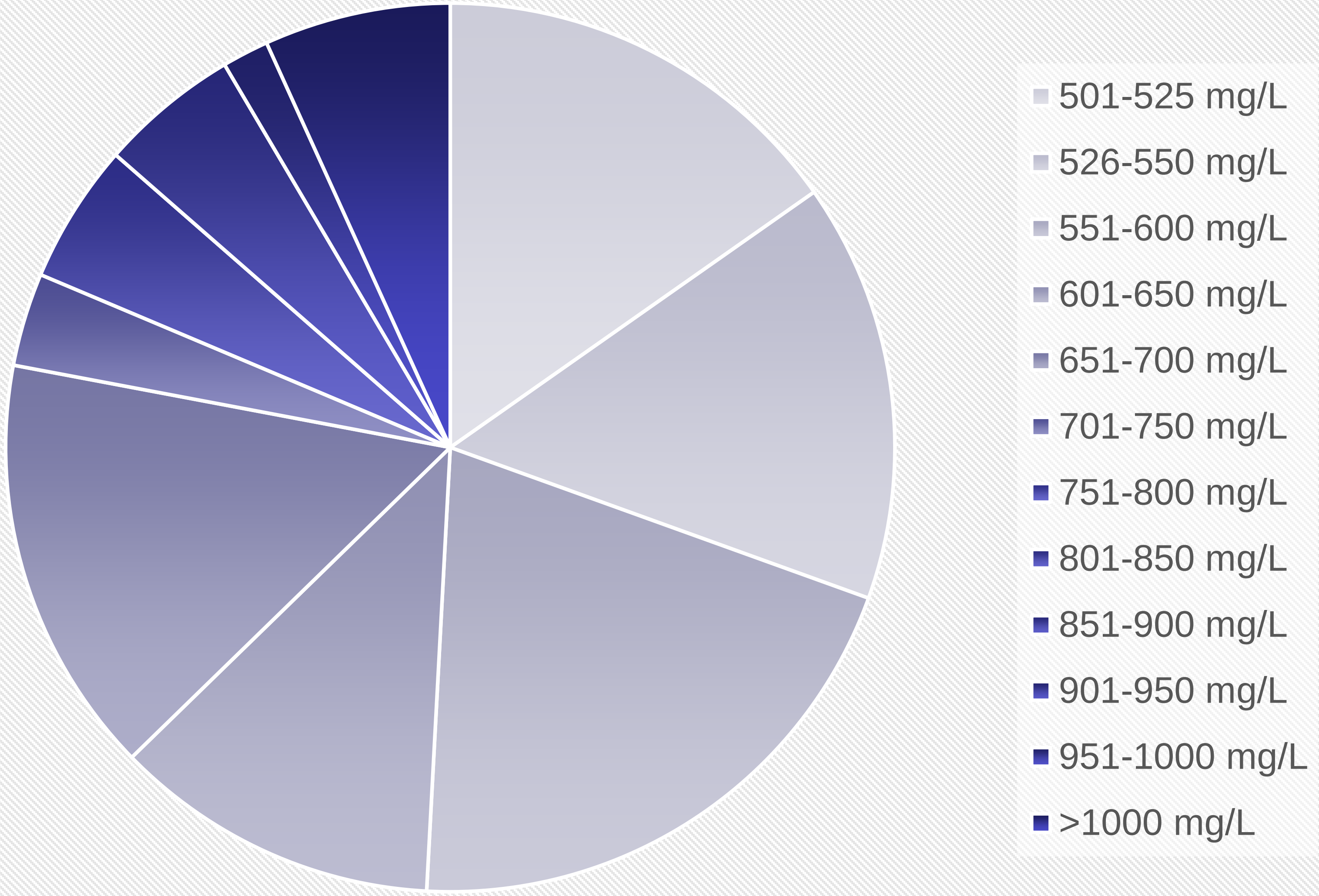
Summary of Chloride Exceedances of 500 mg/L during December - April, 2006 through 2015 in the Chicago Area Waterway System

Location	N Observations	N Excursions	% Excursions
Dempster/Oakton St., North Shore Channel	39	1	2.6
Touhy Avenue, North Shore Channel	48	8	16.7
Diversey Parkway, North Branch Chicago River	50	5	10.0
Wells Street, Chicago River	47	1	2.1
Loomis Street, South Branch Chicago River	49	2	4.1
Archer Avenue, Bubbly Creek	40	5	12.5
Cicero Avenue, Chicago Sanitary & Ship Canal	49	5	10.2
Harlem Avenue, Chicago Sanitary & Ship Canal	49	3	6.1
Stephen Street, Chicago Sanitary & Ship Canal	45	3	6.7
Lockport Forebay, Chicago Sanitary & Ship Canal	205	19	9.3
Burnham Avenue, Grand Calumet River	29	0	0.0
Indiana Avenue, Little Calumet River	27	0	0.0
Halsted Street, Little Calumet River	41	1	2.4
Cicero Avenue, Calumet Sag Channel	38	1	2.6
Route 83, Calumet Sag Channel	38	1	2.6

Magnitude of Exceedances of 500 mg/L Chloride Concentration in the Chicago Area Waterway System During 2006-2015

	North Shore Channel	NB Chicago River	Chicago River	SB Chicago River	Bubbly Creek	CSSC	LCR	GCR	Cal Sag	CAWS-Wide Total
Magnitude of Exceedance										
</=5% greater than WQS	2	0	1	1	3	2	0	0	0	9
6-10% greater than WQS	1	0	0	0	0	8	0	0	0	9
11-20% greater than WQS	3	2	0	0	0	6	0	0	1	12
21-30% greater than WQS	0	1	0	0	0	5	0	0	1	7
31-40% greater than WQS	1	0	0	1	1	5	1	0	0	9
41-50% greater than WQS	0	0	0	0	1	1	0	0	0	2
51-60% greater than WQS	1	0	0	0	0	2	0	0	0	3
61-70% greater than WQS	0	0	0	0	0	0	0	0	0	0
71-80% greater than WQS	0	0	0	0	0	3	0	0	0	3
81-90% greater than WQS	0	0	0	0	0	0	0	0	0	0
91-100% greater than WQS	0	0	0	0	0	1	0	0	0	1
>100% greater than WQS	1	2	0	0	0	1	0	0	0	4
Total >500	9	5	1	2	5	34	1	0	2	59
Total Number of Samples	152	120	116	117	106	907	204	94	214	2030
Exceedance rate (year round)	5.9%	4.2%	0.9%	1.7%	4.7%	3.7%	0.5%	0.0%	0.9%	2.9%
Total Number of Samples (Dec-April)	62	50	47	49	40	369	68	28	76	789
Exceedance rate (December-April only)	14.5%	10.0%	2.1%	4.1%	12.5%	9.2%	1.5%	0.0%	2.6%	7.5%

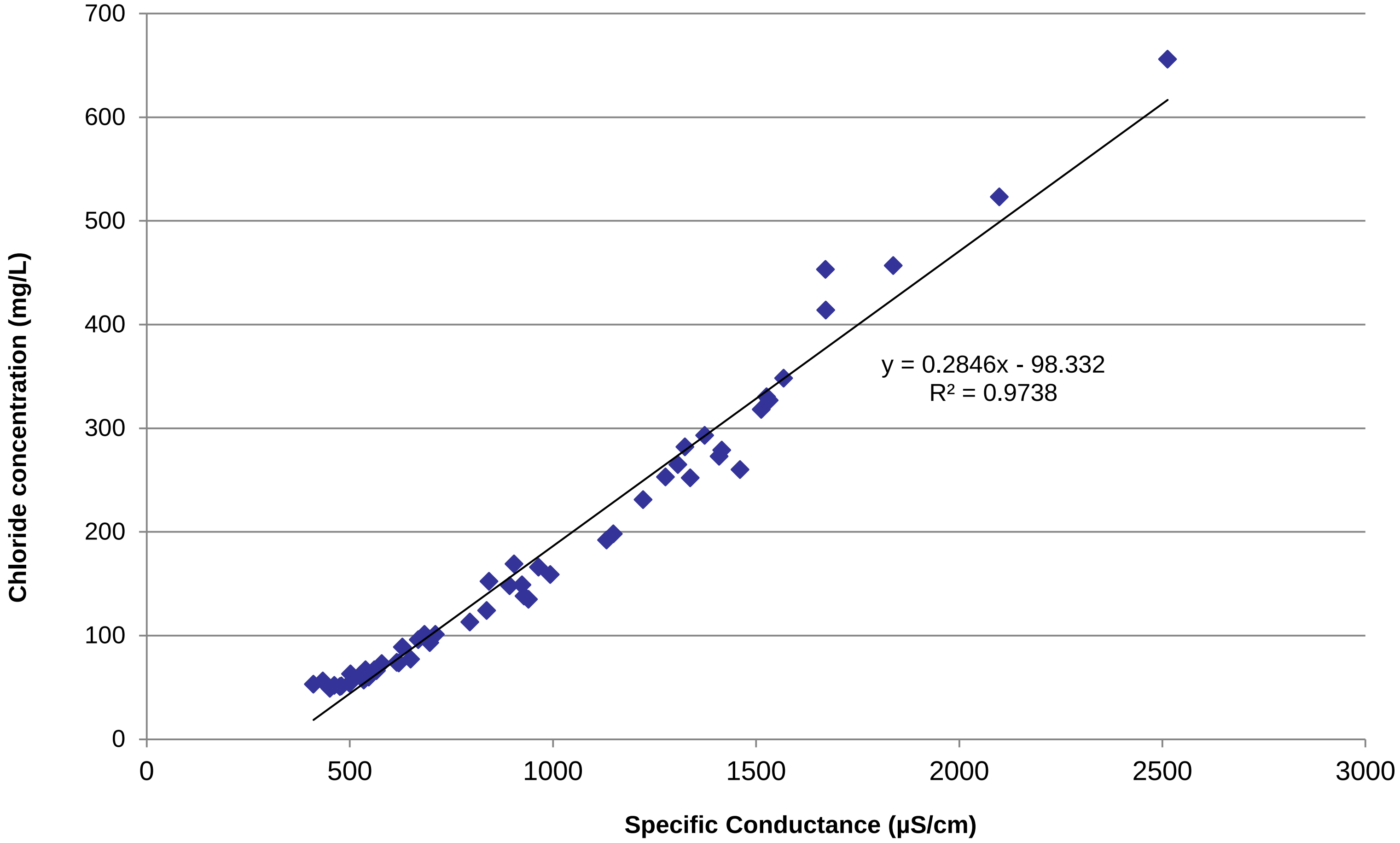
Magnitude of Chloride Exceedances in the CAWS



Developing Conductivity Based Models to Predict Waterway Chloride

- Conductivity Measured Hourly at 14 Locations in the CAWS
  - 9 are co-located with AWQM stations
- Use established relationships between simultaneously collected chloride grab samples and conductivity reading at same or nearby locations in the waterway to estimate hourly chloride concentrations
  - Better understanding of impacts of snow, ice and melting events.

Loomis on the South Branch Chicago River – Linear relationship between Chloride and Specific Conductance



Based on Hourly Conductivity Readings in CAWS Waterways, Winter Months 2011-2015

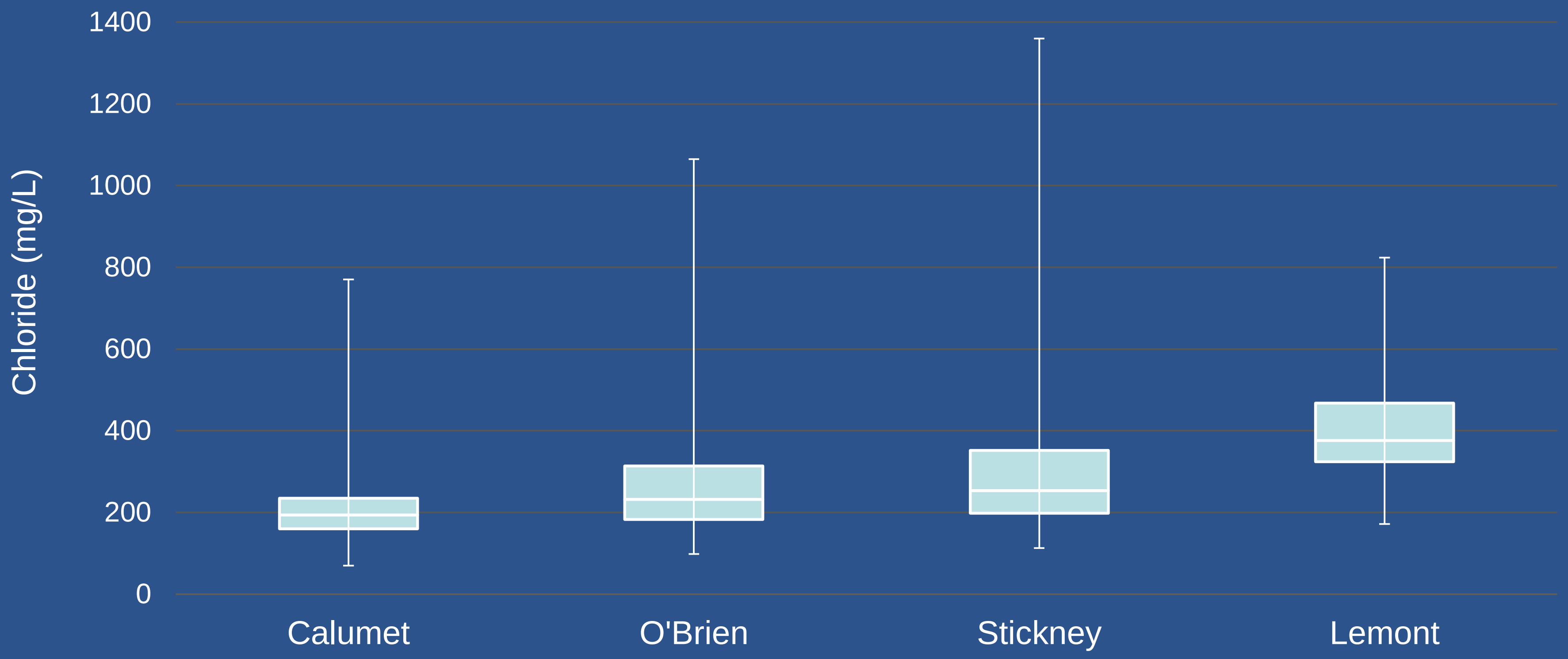
	R^2*	Exceedance rate (500 mg/L) in %	Exceedance rate (990 mg/L) in %
North Shore Channel at Foster Avenue	0.95	7.7 (16.7)	
North Branch Chicago River at Addison Street	0.83	10.6 (12.0)	
Chicago River at Clark Street	0.96	**5.1 (0.0)**	
South Branch Chicago River at Loomis Street	0.97	**8.5 (0.0)**	
Chicago Sanitary and Ship Canal at Cicero Avenue	0.96	11.2 (16.7)	0.02
Chicago Sanitary and Ship Canal at Harlem Avenue	0.96	**10.9 (8.3)**	0.23
Chicago Sanitary and Ship Canal at Lockport	0.92	6.8 (9.7)	0.01
Little Calumet River at Halsted Street	0.95	**1.1 (0.0)**	
Cal-Sag Channel at Cicero Avenue	0.90	**2.4 (0.0)**	

*R^2 of Linear Relationship between Conductivity and Chloride

MWRD Effluent Chloride Concentrations

Summary of Exceedances During Winter Months, December 2014 - April 2016				
	Calumet	O'Brien	Stickney	Lemont
Sample N	303	296	302	151
N >500 mg/L	9	26	32	27
Percent above 500 mg/L	3%	9%	11%	18%
N >990 mg/L	NA	NA	6	0
Percent above 990 mg/L	NA	NA	2%	0%

Effluent Chloride Concentrations During Winter Months 2014-2016



CAWS Chloride Initiative Workgroup

- Purpose
  - Assess current water quality conditions and perform ongoing monitoring to assess changes
  - Document current road deicing activities and salt usage
  - Develop and implement a pollutant minimization plan
  - Identify opportunities to reduce road salt runoff while maintaining public safety
  - Document progress
  - Prepare technical report to be used for discharger variance petitions

CAWS Chloride Initiative Workgroup

- Discharger Variances from Chloride Water Quality Standards
  - Variance is relief mechanism granted by the IPCB that allows petitioners to address the high chloride problem without being subject to a chloride water quality standard for a specified time period.
  - Technical report will address federal and state variance requirements including:
    - Current water quality conditions
    - Best management practices (BMPs) to reduce salt usage and transport to waterways
    - Potential water quality impacts from chloride BMPs
    - Social and economic impacts of salt use reduction

CAWS Chloride Initiative Workgroup

- Participants
  - Municipal
  - Industrial
  - Tollway, CDOT, IDOT
  - Wastewater treatment
  - Non-governmental organizations
  - Regulators

CAWS Chloride Initiative Workgroup

- To achieve these goals, broke up into separate committees
  - Legal
  - BMP
  - Water Quality
  - Data Acquisition
  - Social and Economic Impact

Chloride Best Management Practices

- Proper Salt Storage
  - Impervious pad
  - Completely cover pile
  - Runoff containment
  - Indoor storage
  - Good housekeeping
  - Level loading areas

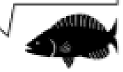
Chloride Best Management Practices

- Anti-icing - Apply liquid brine before storm to prevent bond from forming between pavement and ice
- Pre-wetting - Liquid chemical to solid chemical before applied to road
- Variable Application Rates
  - Pavement temperature
  - Precipitation rate/type
  - Level of service
  - Cycle time
  - Ground speed controllers
- NaCl doesn’t work when it’s <15ºF

Winter Parking Lot and Sidewalk Maintenance

Key Information Needed:
- Pavement Temperature (it will be different than air temperature)
- Parking lot area (or drive lane distance) = Length x Width
- Amount of material your truck or sander delivers at each setting and speed.

Use less! About one tsp. of salt contaminates 5 gallons of water.

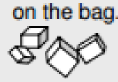


TIPS:
- De-icers melt snow and ice. They provide no traction on top of snow and ice.
- Anti-icing prevents the bond from forming between pavement and ice.
- De-icing works best if you plow before applying material.
- Pick the right material for the pavement temperatures.
- Sand only works on top of snow as traction. It provides no melting.
- Anti-icing chemicals must be applied prior to snow fall.
- NaCl (road salt) does not work on cold days, less than 15º F.

Melt Times for Salt (NaCl) at Different Pavement Temperatures

Pavement Temp. ºF	One Pound of Salt (NaCl) melts	Melt Times
30º	46.3 lbs of ice	5 min.
25º	14.4 lbs of ice	10 min.
20º	8.6 lbs of ice	20 min.
15º	6.3 lbs of ice	1 hour
10º	4.9 lbs of ice	Dry salt is ineffective and will blow away before it melts anything

Pick your material based on lowest practical melting temperature, not eutectic temperature which is often listed on the bag.



Melting Characteristics

Chemical	Lowest Practical Melting Temp.
$CaCl_2$ (Calcium Chloride)	-20º F
KAc (Potassium Acetate)	-15º F
$MgCl_2$ (Magnesium Chloride	-10º F
NaCl (Sodium Chloride)	15º F
CMA (Calcium Magnesium Acetate)	20º F
Blends	Check with manufacturer
Winter Sand/Abrasives	Never melts—provides traction only

Variables affecting application rate

Increase rate:	*Decrease Rate:*
Compaction occurs & cannot be removed mechanically	Light snow or light freezing rain
There is a lot of snow left behind	Pavement temperature is rising
	Subsequent applications

Help protect our lakes, streams, wetlands, and drinking water!

Use best practices for winter maintenance.

Minnesota Pollution Control Agency
FORTIN CONSULTING, INC. serving the environment
CTAP Circuit Training and Assistance Program
ENVIROTECH
University of Minnesota
Scott
LTAP
General Growth Properties, Inc.

October 2010 revision File available at www.pca.state.mn.us/roadsalt

Deicing Application Rate Guidelines for Parking Lots and Sidewalks

These rates are adapted from road application guidelines (Mn Snow & Ice Control Field Handbook, Manual 2005-1). Develop your own application rates using the guidelines as a starting point and modify them incrementally over time to fit your needs. The area should first be cleared of snow prior to applying chemical.

Pavement Temp. (ºF) and Trend (↑↓)	Weather Condition	Maintenance Actions	Application Rate in lbs. per 1000 square foot area			
			Salt Prewetted/ Pretreated With Salt Brine	Salt Prewetted/ Pretreated With Other Blends	Dry Salt	Winter Sand (abrasives)
>30º↑	Snow	Plow, treat intersections only	0.75	0.5	0.75	not recommended
	Frz. Rain	Apply chemical	1.25	1.0	1.5	not recommended
30º↓	Snow	Plow & apply chemical	1.25	1.0	1.5	not recommended
	Frz. Rain	Apply chemical	1.5	1.25	1.75.	not recommended
25 - 30º ↑	Snow	Plow & apply chemical	1.25	1.0	1.5	not recommended
	Frz. Rain	Apply chemical	1.5	1.25	1.75	not recommended
25 - 30º ↓	Snow	Plow & apply chemical	1.25	1.0	1.5	not recommended
	Frz. Rain	Apply chemical	1.75	1.5	2.25	3.25
20 - 25º ↑	Snow or Frz. Rain	Plow & apply chemical	1.75	1.5	2.25	3.25 for frz. rain
20 - 25º ↓	Snow	Plow & apply chemical	2.0	2.0	2.75	not recommended
	Frz. Rain	Apply chemical	2.5	2.0	3.0	3.25
15º to 20º ↑	Snow	Plow & apply chemical	2.0	2.0	2.75	not recommended
	Frz. Rain	Apply chemical	2.5	2.0	3.0	3.2
15º to 20º ↓	Snow or Frz. Rain	Plow & apply chemical	2.5	2.0	3.0	3.25 for frz. rain
0 to 15º ↑ ↓	Snow	Plow, treat with blends, sand hazardous areas	not recommended	3.0	not recommended	5.0 spot treat as needed
< 0º	Snow	Plow, treat with blends, sand hazardous areas	not recommended	4.5	not recommended	5.0 spot treat as needed

To determine the amount of material needed, take the application rate x parking lot area / 1000 ft^2. ***Example:*** Given a 300,000 sq. ft. parking lot and an application rate of 1.5 lbs/1000ft^2 1.5 x 300,000 = 450,000 450,000/1000 = 450 lbs (nine 50 lb. bags).

Anti-Icing Guidelines

These are a starting point only. Adjust based on your experience.

Condition	Gallons/1000 sq. ft.		Other Products
	$MgCl_2$	Salt Brine	
1. Regularly scheduled applications	0.2 - 0.4	0.3 – 0.6	Follow manufacturers' recommendations
2. Prior to frost or black ice event	0.2 - 0.4	0.3 – 0.6	
3. Prior to light or moderate snow	0.2 - 0.4	0.3 – 0.8	

CAUTION: Too high an application rate may result in slippery conditions or tracking.

Chloride Best Management Practices

- Calibration
- Measurement/Accounting
- Training/Accountability
- Public outreach
- Forecasting services

Chloride Best Management Practices

- Green infrastructure
  - Promotes storm-water infiltration rather than rapid/direct runoff to surface streams and wastewater treatment plants.
    - *Bioswales*
    - *Permeable pavement*
  - Reduces need for chloride application in the first place
  - Other benefits
  - May negatively impact groundwater quality; postpones groundwater discharge of NaCl to surface streams.

Assessing how recommended BMPs may impact water quality

- Requirement for Variance Petition
- Plan to use DUFLOW water quality model of CAWS
- Reduce loading from various sources based on BMP literature
- Run model scenarios to predict potential impacts at different CAWS reaches

Other Ongoing Efforts

- Huff and Huff toxicity studies under colder water temperatures
  - Few toxicity studies in cooler water temperatures (<25ºC), but chloride could potentially be less toxic under these conditions according to existing studies
  - Huff proposed acute toxicity studies of certain chloride sensitive organisms at 10º and 25ºC
    - *Water flea, mayfly, fingernail clam, amphipod*
  - Develop science concerning cold temperature chloride toxicity
  - Propose different chloride standards based on findings

Other Ongoing Efforts

- Water Equipment & Policy NSF Grant Project
- David Strifling, Director, Water Law and Policy Initiative, Marquette University Law School
  - *Reducing chloride discharges to area waterways: a menu of options for policymakers*
  - Literature review
  - Analysis of existing programs and policies
  - Examines several potential responsive policy options for chlorides
  - Menu of recommended options for policymakers including rationale

Numerous resources for Chloride BMPs

- http://www.saltinstitute.org//
- https://www.wisaltwise.com/
- http://ops.fhwa.dot.gov/weather/weather_events/snow_ice.htm
- http://des.nh.gov/organization/divisions/water/wmb/was/salt-reduction-initiative/
- https://www.pca.state.mn.us/water/road-salt-and-water-quality
    - WMAt (Winter Maintenance Assessment tool)

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